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Application Date: 2003 06 13

Application Number: 03 2 47291.9

Application Type: Invention

Title: Lithium Ion Batteries

Applicant: BYD LTD.

Inventors: Chuanfu Wang, Dehe Mao, Haitiao Wang and Hua Wu

People's Republic of China
Commissioner of the State Intellectual
Property Office (signed) Wang Jingchuan
January 5, 2004

证 明

本证明之附件是向本局提交的下列专利申请副本

申 请 日： 2003 06 13

申 请 号： 03 2 47291.9

申 请 类 别： 实用新型

发明创造名称： 锂离子电池

申 请 人： 比亚迪股份有限公司

发明人或设计人：王传福；毛德和；王海涛；吴华

中华人民共和国
国家知识产权局局长 王景川

2004 年 1 月 5 日

权 利 要 求 书

1.一种锂离子电池，包括电芯、电池保护线路板与端盖，电芯中的正负极片的极耳先与电池保护线路板连接，再通过电池保护线路板的接触极片与负载或充电器相连，在端盖上开有使电池保护线路板的接触极片能与外界接触的空腔及开孔，其特征在于：端盖事先采用树脂或者塑胶注射成型的方式制成；在端盖的两个端部还分别开有一个开孔，在电芯顶部的壳体上与端盖端部开孔对应的位置上也分别开有一个开孔；电芯顶部的开孔与电芯的内部之间具有足够的安全距离；两个螺丝钉分别穿过端盖上的开孔拧到电芯顶部的开孔中，把端盖与电芯连接在一起。

2.如权利要求1所述的锂离子电池，其特征在于：所述的端盖由上、下两块盖板构成，电池保护线路板置于上、下两块盖板之间。

3.如权利要求1所述的锂离子电池，其特征在于：在电芯顶部的开孔中具有内螺纹。

4.如权利要求1所述的锂离子电池，其特征在于：在电芯顶部开孔的旁边开有定位孔，在端盖上与电芯顶部上的定位孔相对应的位置上设有定位小突起。

5.如权利要求1所述的锂离子电池，其特征在于：所述的安全距离为0.3毫米以上。

6.如权利要求1所述的锂离子电池，其特征在于：所述的螺丝钉上以及壳体与端盖之间均涂有密封胶。

说明书

锂离子电池

【技术领域】

本实用新型涉及一种锂离子电池，尤其是涉及一种用于移动电话、PDA等移动终端设备的可充电的锂离子电池。

【背景技术】

锂离子电池作为一种新型的高容量、高输出功率、安全、环保、无污染的可充电电池，近年来在移动电话、笔记本电脑、PDA等设备中得到了越来越广泛的应用，目前已经成为这些设备的标准配置。

锂离子电池一般由电芯、电池保护线路板和塑胶外壳等部分组成。电池保护线路板置于壳体内部电芯与壳体之间。塑胶外壳用于固定电芯和电池保护线路板的相对位置以及对线路板进行保护。电芯的内部包含有正负极片、隔膜和电解液。整个电芯采用金属外壳封装，在电芯的外部有分别与内部的正负极片相连的正负极耳。正负极耳先与电池保护线路板连接，再通过电池保护线路板的接触极片与负载，如移动电话、笔记本电脑、PDA等的本体或者充电器相连。这种方式的电池由于需要一个单独制造的塑胶外壳，因而成本较高，由电池的电芯组装成电池成品的过程也较为复杂、不方便。

为解决上述问题，最新的锂离子电池则省去了塑胶外壳，而在电芯的上下两个端部设置了两个端盖。端盖采用整体灌胶的方式制成，把电池保护线路板胶在端盖与电芯之间。端盖上开有能使电池的正负极片及电池保护线路板的接触极片能与外界接触的空腔及开孔。这种方式的缺陷在于：整体灌胶的制造工艺比较复杂，成本也较高，并且端盖与电芯之间结合的牢固程度也较低。为了增强端盖与电芯之间结合的牢固程度，日本松下公司在壳体的两个端部采用焊接方式先分别固定住一个铆钉，再采用灌胶的方式制成端盖并使之与电芯连接在一起。这种方式在一定程度上提高了端盖与电芯结合的牢固程度，但是其工艺更加复杂，仍然不能解决成本高的问题。

【实用新型内容】

本实用新型所要解决的技术问题是提供一种工艺简单、成本较低、电池端盖与电芯之间结合牢固的锂离子电池。

为解决上述技术问题，本实用新型的技术方案是：

锂离子电池，包括电芯、电池保护线路板与端盖，电芯中的正负极片的极耳先与电池保护线路板连接，再通过电池保护线路板的接触极片与负载或者充电器相连接，用于对移动电话、笔记本电脑、PDA 等的本体提供电源或者由充电器对电池进行充电。在端盖上开有能使电池保护线路板的接触极片与外界接触的空腔及开孔，端盖事先采用树脂或者塑胶注射成型的方式制成。此外在端盖的两个端部还分别开有一个开孔。在电芯顶部与端盖端部开孔对应的位置上也分别开有一个开孔。电芯顶部的开孔与电芯的内部之间具有足够的安全距离，以保证电池在日后的使用中不至于泄漏。两个螺丝钉分别穿过端盖上的开孔拧到电芯顶部的开孔中，把端盖与电芯连接在一起。

作为对本实用新型技术方案的改进，所述的端盖可以由上、下两块盖板构成，电池保护线路板置于上、下两块盖板之间。

作为对本实用新型技术方案的改进，在电芯顶部开孔的旁边还开有定位孔，在端盖上与电芯顶部上的定位孔相对应的位置上设有定位小突起。

作为对本实用新型技术方案的改进，所述的螺丝钉上以及电芯与端盖之间均涂有密封胶。

作为对本实用新型技术方案的改进，在所述的电芯顶部的开孔中可以具有内螺纹。

本实用新型由于端盖事先采用树脂或者塑胶注射成型的方式制成，并且端盖与壳体间采用螺丝钉连接的方式，从而大大简化了生产工艺，降低了成本，并且同时也增强了端盖与电芯结合的牢固程度。

当端盖采用上、下两块盖板，并把电池保护线路板置于上、下两块盖板之间时，能够对电池保护线路板起到支撑和隔离作用，并且有助于固定电池保护线路板与电芯之间的相对位置关系。

【附图说明】

下面参照附图结合实例对本实用新型作进一步的说明：

图 1 是本实用新型锂离子电池的整体外观示意图；

图 2 是本实用新型锂离子电池的电芯外观示意图；

图 3 是本实用新型一种实施例的电池端盖与电芯分解开的结构示意图；

图 4 是本实用新型另一种实施例的电池端盖与电芯分解开的结构示意图。

【具体实施方式】

本实用新型锂离子电池的一种具体实施方式如图 1 至图 3 所示，包括电芯 6、电池保护线路板 2 与端盖 1。其中电芯 6 的内部包含有正极片、负极片、正负极集流体、用于把正负极片分开的隔膜纸以及电解液。整个电芯 6 采用金属壳体封装，所用的金属可以是铝、不锈钢、或者镀镍的普通钢等。如图 2 所示，在电芯 6 的顶部有一块与其金属壳体材质相同的盖板 14，盖板 14 在电芯 6 组装完以后以激光焊接的方式与金属壳体结合在一起。在盖板 14 上设有与电芯 6 内部的负极片相连的负极耳 13，电芯 6 内部的正极片与电芯 6 的金属壳体及盖板 14 相连，然后再在盖板 14 上连接一个金属片成为正极耳，在负极耳 13 和与电池正极相连的盖板 14 之间设有绝缘层；在盖板 14 上还设有防暴孔 12 和注液孔 15。防暴孔 12 当电池内部压力过高时能自动释放压力以保证电池的安全；注液孔 15 用于当电芯 6 全部组装好以后向其内部注入电解液，注液孔当注液完成以后，再用金属片将其焊接封闭起来。电池保护线路板 2 和保护器 4 置于端盖 1 与电芯 6 之间，电池保护线路板 2 具有过充、过放和过电流保护的功能，能够避免电池过度的充电、放电以及充电时电流过大等情况对电池造成损坏。保护器 4 具有温度保护功能，在充电时如果电池温度上升过高时，保护器 4 能够自动断开电源，以保护电池的安全。与电芯 6 中的负极片相连的负极耳 13 先与保护器 4 连接，通过保护器 4 再与电池保护线路板 2 连接。与电芯 6 顶部的盖板 14 相连的正极耳通过连接器 9 直接与电池保护线路板 2 连接。电池保护线路板 2 具有用于与负载，如移动电话、笔记本电脑、PDA 等的本体或者充电器相连的正负极接触极片以及用于识别电池类型等用途的接触极片。在端盖 1 上开有使电池保护线路板 2 的接触极片能与外界接触的方形开孔 10 和用于对电池和线路板 2 的性能进行测试的圆形开孔 11。电芯 6 中的正负极片分别通过各自的极耳、保护器 4 和电池保护线路板 2 以后，再通过电池保护线路板 2 的正负极接触极片与负载或者充电器连接。以实现对负载提供电源或者由充电器对电池进行充电。

端盖 1 的两个端部分别开有一个开孔。在电芯 6 的顶部与端盖 1 端部开孔相对应的位置上也分别开有一个开孔，电芯 6 顶部的盖板 14 在这两个开孔的位置处具有足够的厚度，能保证开孔与电芯 6 的内部之间仍有足够的安全距离，使电池在日后的使用中不至于泄漏。这个安全距离最好应当在 0.3 毫米以上。两个螺丝钉 5 分别穿过端盖上的开孔拧到电芯 6 的开孔中，把端

盖 1 与电芯 6 连接在一起。端盖 1 由一块盖板构成，在电芯 6 与电池保护线路板 2 之间用绝缘纸 8 来隔离。端盖 1 事先采用树脂或者塑胶注射成型的方式制成。由于作为原料的树脂或者塑胶的成本很低，并且采用注射成型的方式工艺也简单，因此大大的简化了生产工艺、降低了成本。

由于电芯 6 的金属外壳一般是由金属铝制成，金属铝比较柔软，因此在电芯 6 上的金属外壳的开孔中并不一定要有内螺纹，当螺丝钉 5 拧到电芯 6 外壳的开孔中时，会自然的在开孔中形成螺纹。当然，在电芯 6 外壳上的开孔中也可以先刻上内螺纹，这时，此时电芯 6 外壳的顶部盖板可以采用较硬的材料如不锈钢等构成。采用这种方式有助于提高端盖 1 与电芯 6 结合的牢固程度。

为了进一步提高端盖 1 与电芯 6 之间连接和密封的牢固程度，还可以在螺丝钉 5 上以及 6 与端盖 1 之间涂上密封胶。采用螺丝钉复合密封胶连接的方式能使端盖 1 紧紧地与电芯 6 结合在一起。在电芯 6 的底部还有一个底盖 7。底盖 7 也采用树脂或者塑胶注射成型的方式制成，用密封胶与电芯 6 胶结在一起。

本实用新型锂离子电池的另一种具体实施方式如图 4 所示，与实施例 1 的差别在于：端盖 1 由上、下两块盖板构成，其中下盖板构成了电池保护线路板 2 的托架 3，电池保护线路板 2 置于上、下两块盖板之间。托架 3 也是事先采用树脂或者塑胶注射成型的方式制成，用密封胶与电芯 6 胶结在一起。保护器 4 置于托架 3 之下。托架 3 能够对电池保护线路板 2 起到保护和隔离作用，有助于保证线路板 2 和电池的安全，由于有托架 3 的存在，因此在本实施例中不需要绝缘纸 8。

在本实施例中，为了在生产、装配的过程中，使端盖 1 能够准确、迅速的定位在电芯 6 上，在电芯 6 顶部开孔的旁边另外各设置了一个定位孔，在端盖 1 的下部与电芯 6 上的定位孔相对应的位置上相应的各设置了一个定位小突起。

上述实施例只是体现本实用新型技术方案的优选方案，本技术领域的技术人员对其中的某些部分所可能做出的一些变动均体现了本发明的原理，属于本发明的保护范围之内。

说明书附图

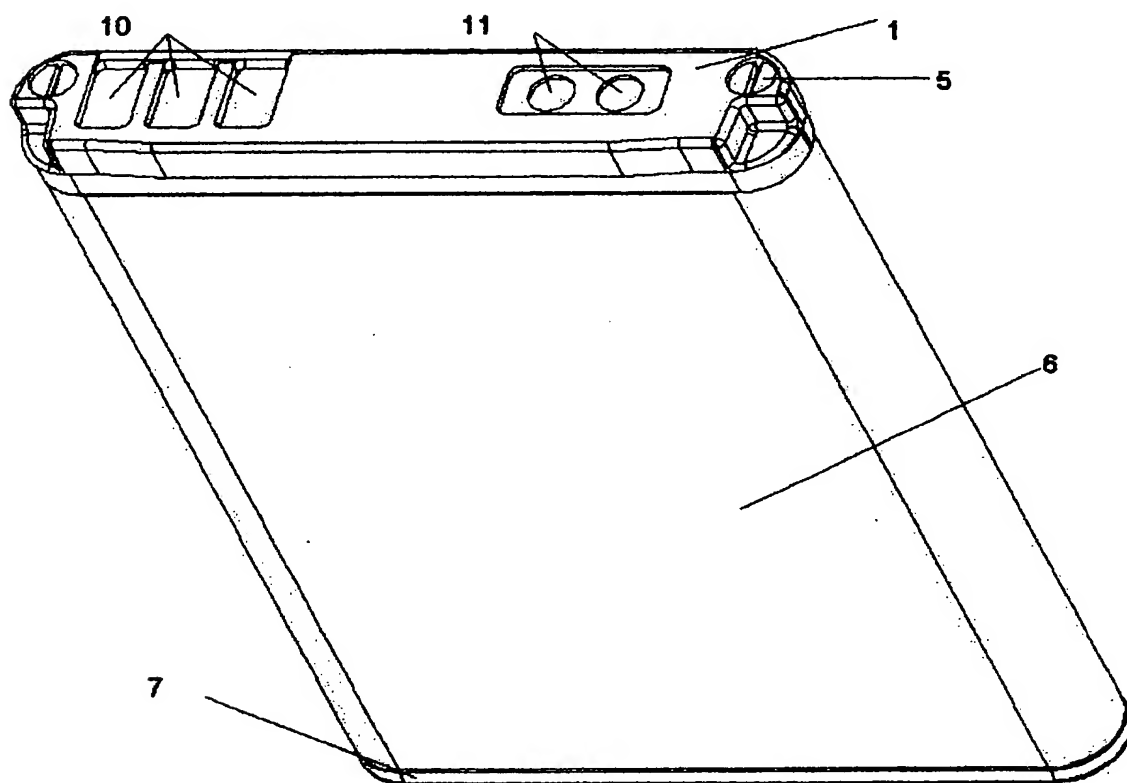


图 1

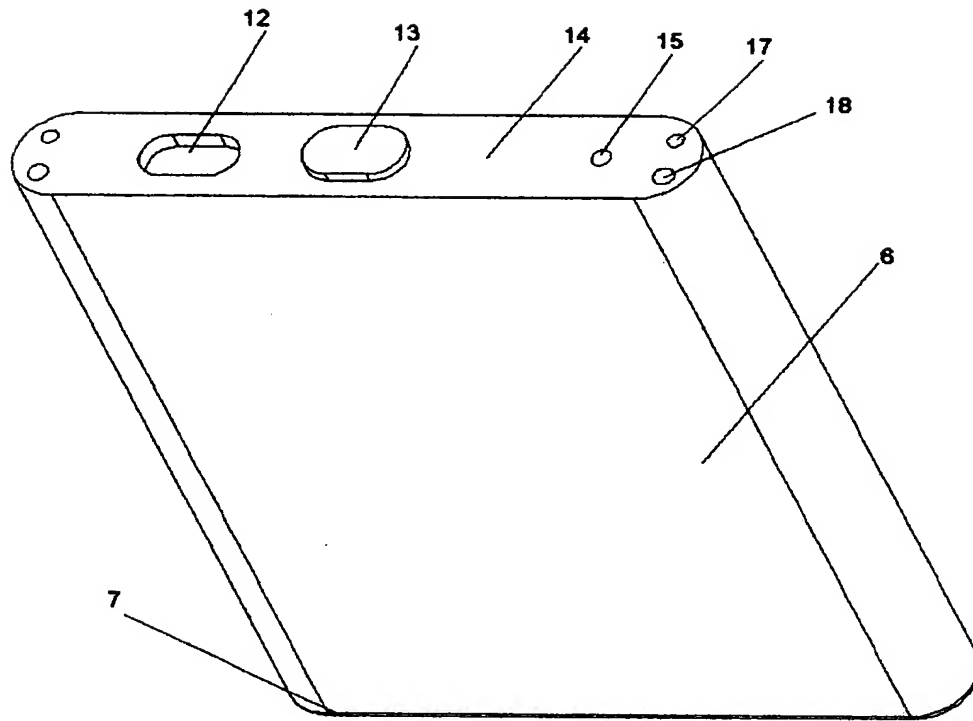


图 2

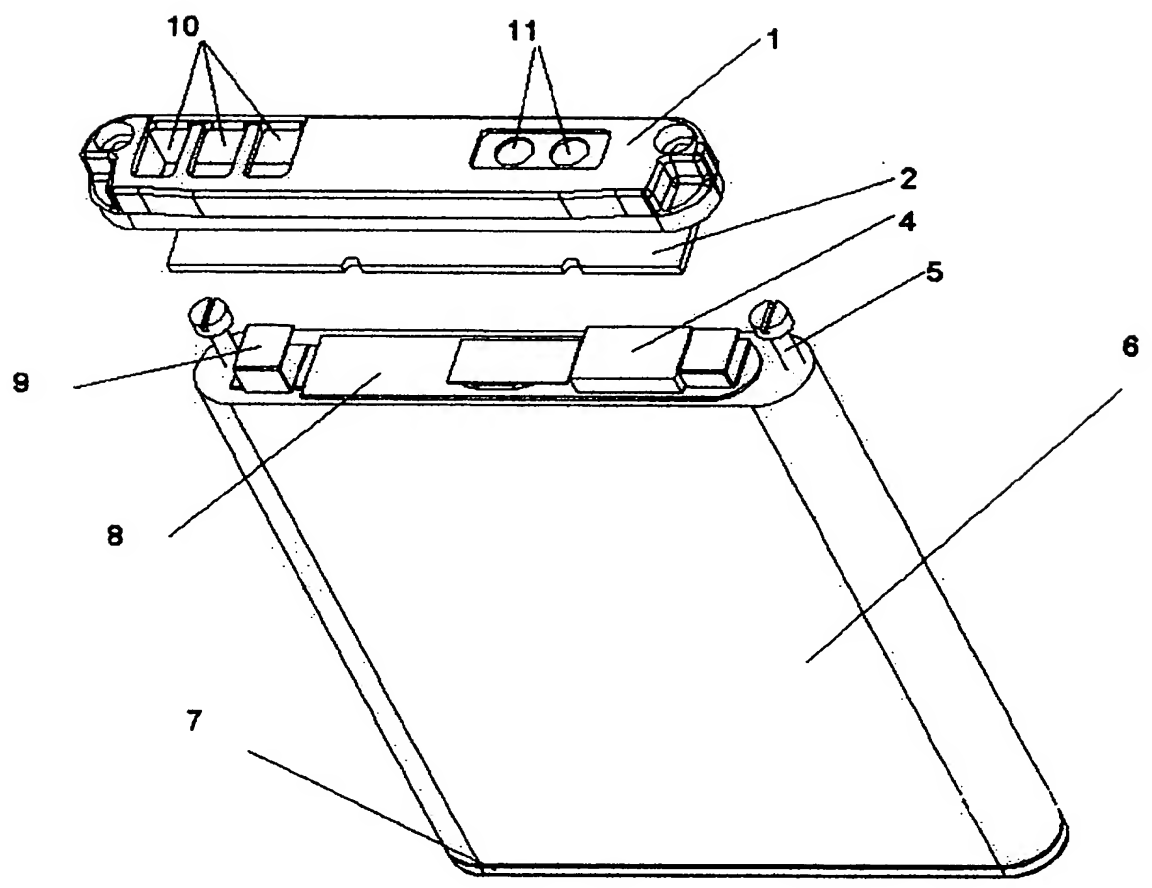


图 3

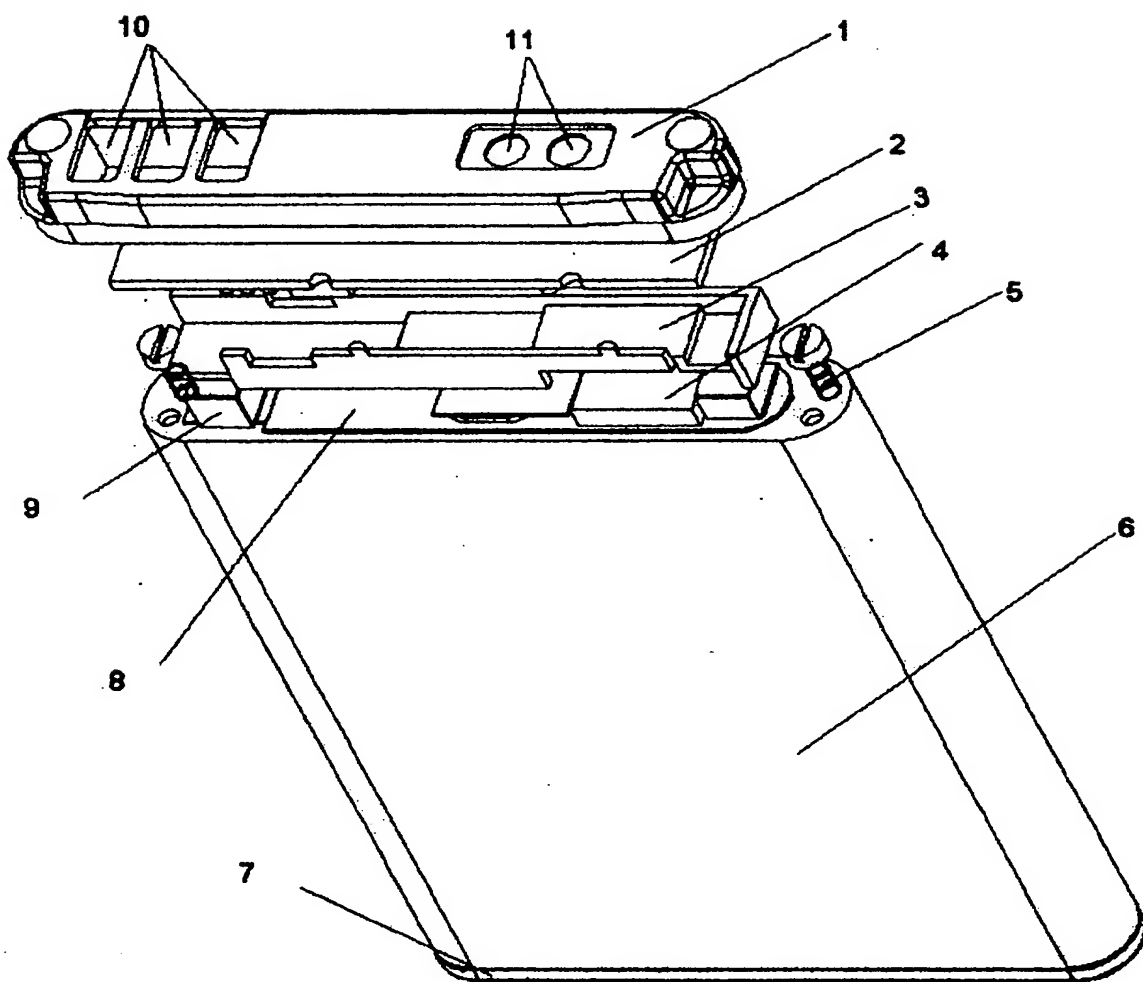


图 4

ENGLISH TRANSLATION DOCUMENT

The following attached document is the English Translation Document for the below referenced Chinese patent application.

Application Date: 2003 06 13

Application Number: 03 2 47291.9

Application Type: Utility Model

Title: Lithium Ion Batteries

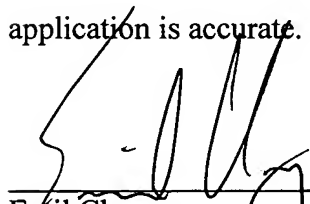
Applicant: BYD LTD.

Inventors: Chuanfu Wang, Dehe Mao, Haitiao Wang, Hua Wu

Attorney Docket: BYD-US2003-011

Translation Certification

I hereby certify that the following translation of the above-referenced patent application is accurate.



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CERTIFICATION

This certification certifies the attached copy is a copy of the patent application filed with this Office.

Application Date: 2003 06 13

Application Number: 03 2 47291.9

Application Type: Utility Model

Title: Lithium Ion Batteries

Applicant: BYD LTD.

Inventors: Chuanfu Wang, Dehe Mao, Haitiao Wang, Hua Wu

People's Republic of China

Commissioner of the State Intellectual

Property Office (signed) Wang Jingchuan

January 5, 2004

Abstract

This invention discloses a type of lithium ion battery, including a battery core, a battery protective circuit and a cover. The cover can be injection molded from rubber or plastic. There is an opening at each of the two ends of the cover and one or more openings on top of the battery core and corresponding opening on the cover. There are two screws each one piercing through an opening on the cover into an opening on the top of the battery core, thereby connecting the cover and the battery core. In comparing to prior art, the present invention significantly reduces manufacturing costs and simplifies the manufacturing process.

Specification

Lithium ion batteries

5 Field of Invention

The present invention relates to a type of lithium ion battery, and, in particular, a type of rechargeable lithium ion battery suitable for use in mobile phones, PDAs, and mobile equipment.

10 Background

Lithium ion battery is a new type of high capacity, high output, safe, environmentally friendly, and non-pollutive rechargeable battery. It has wide applications for use in equipments such as mobile phones, laptop computers, PDAs, etc. and has become the standard accessory for these types of equipments.

15 Lithium ion battery typically is comprised of a battery core, a battery protective circuit, a plastic external shell, etc. The battery protective circuit is placed within the shell between the battery core and the shell. The plastic external shell is used to secure the corresponding position between the battery core and the battery protective circuit and to protect the battery protective circuit. Within the battery core, there are positive and
20 negative electrodes, one or more separators, and electrolyte. The entire battery core is encased in a metal external shell. On the exterior of the battery core, there are positive and negative terminals connecting to the interior positive and negative electrode of the battery core. The positive and negative terminals are first connected to the battery

protective circuit. Then through the contact points of the battery protective circuit, it is connected to the body or the charger of the mobile phone, laptop computer, PDA, etc. to carry the load of such devices. This type of battery needs a separately manufactured plastic shell, resulting in higher costs. Also, it is more complicated and less convenient in the assembling of the battery core into a battery product.

In order to solve the above problem, the newest lithium ion batteries use a plastic external shell. A cover is provided on each of the top and bottom end of the battery core. The cover is made by injection molding methods, and the battery protective circuit is glued between the cover and the battery core. On top of the cover, there are openings and holes provided to allow the contact plates of the battery be exposed to the outside world, where the contact plates are connected to the battery protective circuit and the positive and negative electrodes. The disadvantage of this method is that the injection molding process is more complicated, the cost is higher, and the adhesion between the cover and the battery core is low as well.

In order to increase the hold between the cover and the battery core, Japanese company, Matsushita, first welds a nail to each of the two ends of the shell body. Then, it uses an injection molding method to manufacture the cover that is secured to the battery core. This method to a certain degree increased the hold between the cover and the battery core. However, the manufacturing process is more complex and it still does not resolve the cost issue.

Description of the Invention

A goal of the present invention is to provide a type of lithium ion battery having strong hold between the battery cover and the battery core.

Another goal of the present invention is to provide a lithium ion battery having a simple manufacturing process and low cost.

5 In order to achieve the above goals, the technical method of the present invention is:

A type of lithium ion battery, including a battery core, battery protective circuit and a cover. There are openings and holes on the cover. The special characteristics are: the cover is a separate unit; there is a hole on each of the two ends of the cover; there is a
10 sufficiently safe distance between the opening at the top of the battery core and the interior of the battery core; and there are two screws each inserted through a hole on top of the cover and fastened to a hole on top of the battery core in order to connect the cover to the battery core.

An improvement to the above-described method, the cover is first injection
15 molded using rubber or plastic.

The above described cover can be structured using top and bottom cover plates. The battery protective circuit is placed between the top and bottom cover plates.

There can be placement holes near the opening on the top of the battery core. There are small position notches on the cover at positions corresponding to the openings
20 on the top of the battery core.

Adhesive sealer is smeared on the described screws and between the cover and the battery core.

There can be threads in the openings on the top of the battery core.

The cover of the present invention is a separate piece. Additionally the cover and the shell body are secured by the use of screws. Comparing to prior art technologies, it increased the hold between the cover and the battery core.

5 The cover is first separately manufactured with an injection molding method using rubber or plastic. This method simplifies the manufacturing process and lowers manufacturing costs.

When top and bottom covers are used and the battery protective circuit is placed between the top and bottom covers, the covers can be used to support and segregate the battery protective circuit and used to defined the position of the battery protective circuit
10 relative to the battery core.

Description of the Figures

The combination of figures and embodiments further describe the present invention:

15 Figure 1 is an external view of the complete lithium ion battery;

Figure 2 is an external view of the battery core of the lithium ion battery;

Figure 3 is the break out of an embodiment of the structure of the battery cover and the battery core;

Figure 4 is the break out of another embodiment of the structure of the battery
20 cover and the battery core.

Embodiments

The lithium ion batteries of the present invention, an embodiment of which as illustrated by Figures 1 and Figure 3, including battery core 6, battery protective circuit 2, and cover 1. Referring to the Figures, cover 1 is a separate unit. Inside the battery core 6 includes positive and negative electrodes, positive and negative terminals, insulation for separating the positive and negative electrodes, and electrolyte. The battery core 6 is sealed and encased in a metal shell, the metal of which can be aluminum, stainless steel, electro-plated nickel, etc. As illustrated in Figure 2, on the top of the battery core 6 there is a top-side plate 14 having the same material as the metal shell of the battery core.

After assembling of the top-side plate 14 and the battery core 6, the top-side plate is spot welded to the metal shell body. On the top-side plate 14, there is a negative terminal 13 connected to the negative electrode inside of the battery core 6. The positive electrode of the battery core 6 is connected to the metal shell of the battery core 6 and the top-side plate at 14, and a metal plate is connected to the top-side plate 14 to form the positive terminal. There is an insulation barrier between the negative terminal 13 and the top-side plate 14 connecting to the positive terminal. On the top-side plate 14, there is also a release valve 12 and a fill hole 15. The release valve 12 automatically releases excessive internal pressure built-up in order to provide battery safety. The fill hole 15 is used, after the battery core 6 is completely assembled, to fill electrolyte into the interior. The fill hole 15, after filling the electrolyte, is sealed by welding a metal plate over it.

The battery protective circuit 2 and a safety unit 4 are placed between cover 1 and the battery core 6. The battery protective circuit 2 provides overcharging, excessive-discharging, and excessive current functions, preventing the battery from overcharging, excessive-discharging, and excessive current during charging, and other conditions that

may damage the battery. Safety unit 4 provides temperature protection function. If the temperature rises excessively high during charging, safety unit 4 will automatically cut off the source to protect the battery. The negative terminal 13, which is connected to the negative electrodes of the battery core 6, is first connected to the safety unit 4, and

5 through the safety unit 4 is connected to the battery protective circuit 2. The positive terminal, which is connected to the top-side plate 14 on top of the battery core 6, through the connecting unit 9 connects directly to the battery protective circuit 2. The battery protective circuit 2 interacts, for example, within the body of mobile phones, laptop computers, PDAs, etc. or with the respective charging unit. It connects to positive and

10 negative contact plates and it provides contact points for identifying the battery type. On the cover 1, there are square openings 10 for allowing exterior contact to the contact plates of the battery protective circuit board 2, and circular openings 11 for allowing testing of the battery and the battery protective circuit 2. The positive and negative electrodes of the battery core 6, through each respective terminal, safety unit 4, and the

15 battery protective circuit 2, and through the positive and negative contact plates of the battery protective circuit, connect with the load or charger, in order to provide voltage source or receive charge to the battery.

There is an opening on each side of the cover 1. There are also openings on top of the battery core 6 at positions corresponding to the openings on the cover 1. The top-

20 side plate 14 on top of the battery core 6 and between these two openings has sufficient thickness to guarantee that there is a safe distance between the openings and the battery core 6 and to ensure that the battery does not leak during usage. After much empirical studies and research, when using aluminum as the common material for the outer shell of

the battery, the safety distance should be over 0.3 mm, preferably between 0.3 to 0.6 mm. If it is less than 0.3 mm, then it is easier for leakage to occur. If it is greater than 0.6 mm, it would result in waste and it would not be necessary. The two screws 5 each is inserted through the openings on the cover and screwed into the openings on the battery core 6, in order to secure the cover 1 to the battery core 6. The cover 1 is formed by a cover plate, and a piece of insulation paper is placed between the battery core 6 and the battery protective circuit 2 to insulate them. The cover 1 is first made by injection molding using rubber or plastic. Due to the low cost of rubber or plastic as the raw material and that injection molding is also a simple manufacturing method, the manufacturing process is simplified and the cost is lowered.

The outer shell of the battery core 6 is typically made from the metal aluminum. Aluminum is typically soft, thus the openings on the outer shell of the battery core 6 need not have threads in the openings. When the screws are secured into these openings on the outer shell of the battery core 6, it will naturally form the threads in the openings. Obviously, threads can be first formed in the openings on the outer shell of the battery core 6 as well; if so, a harder material can be used for the top portion of the outer shell of the battery core 6, such as stainless steel. This method increases the hold between the cover 1 and the battery core 6.

In order to increase the hold and the seal between the cover 1 and the battery core 6, adhesive sealer can be applied to the screws 5 and between the battery core 6 and the cover 1. By using the screws in combination with the adhesive sealer, the cover 1 and the battery core 6 can be tightly fastened. On the bottom of the battery core 6, there is also a

bottom cover 7. The bottom cover 7 is also made by injection molding using rubber or plastic, and is glued on to the battery core 6 using adhesive sealer.

Figure 4 shows an illustration of another embodiment of the present invention of a lithium ion battery. It differs from the first embodiment in several respects. The cover 1 is formed by a top and bottom two piece cover plates. The bottom cover plate is used as support 3 for the battery protective circuit 2, where the battery protective circuit 2 is placed between the top and bottom covers. The support 3 is also separately made by injection molding using rubber or plastic, and glued to the battery core 6 using adhesive sealer. The protective unit 4 is placed under the support 3. The support 3 provides protection and insulation functions to the battery protective circuit 2, ensuring the safety of the battery protective circuit 2 and the battery. Because of the existence of the support 3, this embodiment does not require insulation paper 8.

In this embodiment, in the manufacturing and assembling process, in order to quickly and accurately position cover 1 on the battery core 6, position holes are provided near the openings on the top of the battery core 6. On the bottom of cover 1 and on the corresponding positions of the position holes on top of the battery core 6, small position notches are provided.

The above described positional holes and position notches can be used in the first embodiment as well.

While the above described embodiments disclosed the objects and advantages of the present invention, however, the present invention is not limited to the above embodiments. Under the general principles of the present invention, as long as modifications to certain portions made by those of ordinary skilled in the art of this field

as within the claims of this invention, they are considered to be within the protective boundary of this invention.

CLAIMS

1. A type of lithium ion battery, including a battery core, battery protective circuit and a cover; there are openings and holes on the cover; the special characteristics are: the cover is a separate unit; there is a hole on each of the two ends of the cover; there is a sufficiently safe distance between the opening at the top of the battery core and the interior of the battery core; and there are two screws each inserted through a hole on top of the cover and fastened to a hole on top of the battery core in order to connect the cover to the battery core.

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2. As claim 1 reciting to lithium ion battery, with special characteristic: the cover is first made by rubber or plastic by using an injection molding method.

3. As claim 1 reciting to lithium ion battery, with special characteristic: the described cover is formed by top and bottom cover plates, where the battery protective circuit is placed between the top and bottom cover plates.

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4. As claim 1 reciting to lithium ion battery, with special characteristic: there are thread marks in the openings on the top of the battery core.

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5. As claim 1 reciting to lithium ion battery, with special characteristic: there are position holes provided near the openings on the top of the battery core 6; and on the

bottom of cover 1 and at the corresponding positions of the position holes on top of the battery core 6, small position notches are provided.

6. As claim 1 reciting to lithium ion battery, with special characteristic: the
5 described safety distance is 0.3 mm to 0.6 mm.

7. As claim 1 reciting to lithium ion battery, with special characteristic: adhesive sealer is smeared on the described screws and between the cover and the battery core.

FIGURES

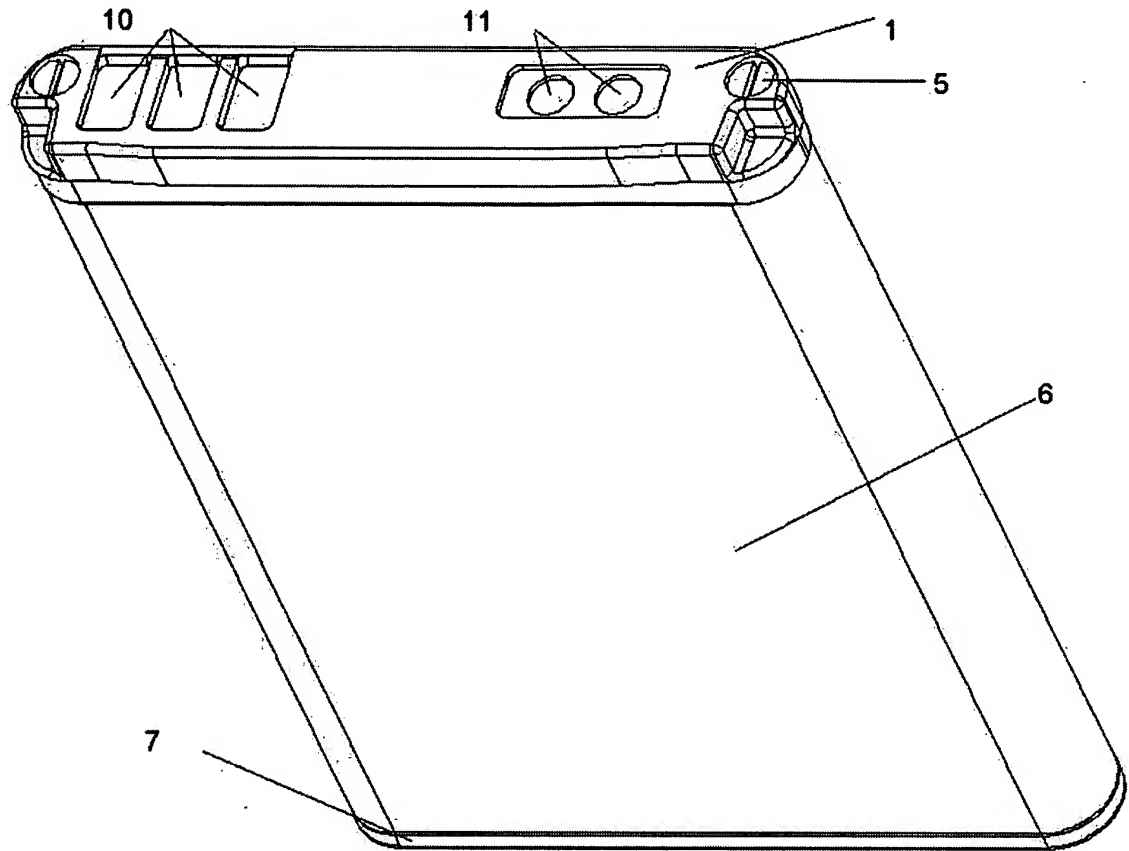


Figure 1

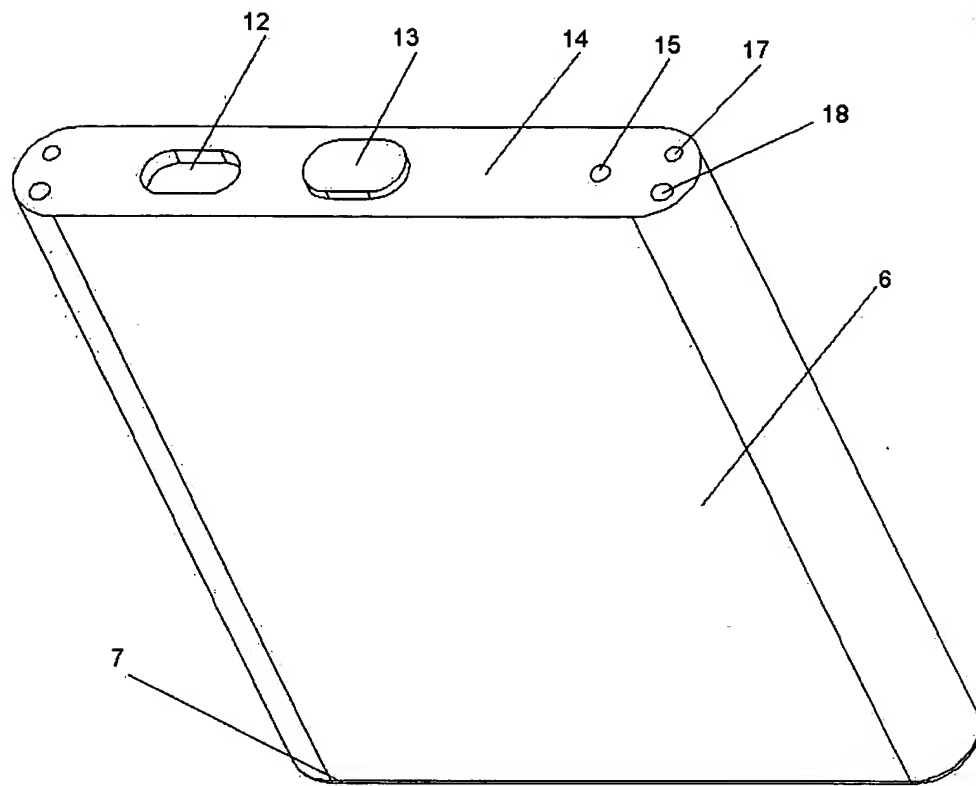


Figure 2

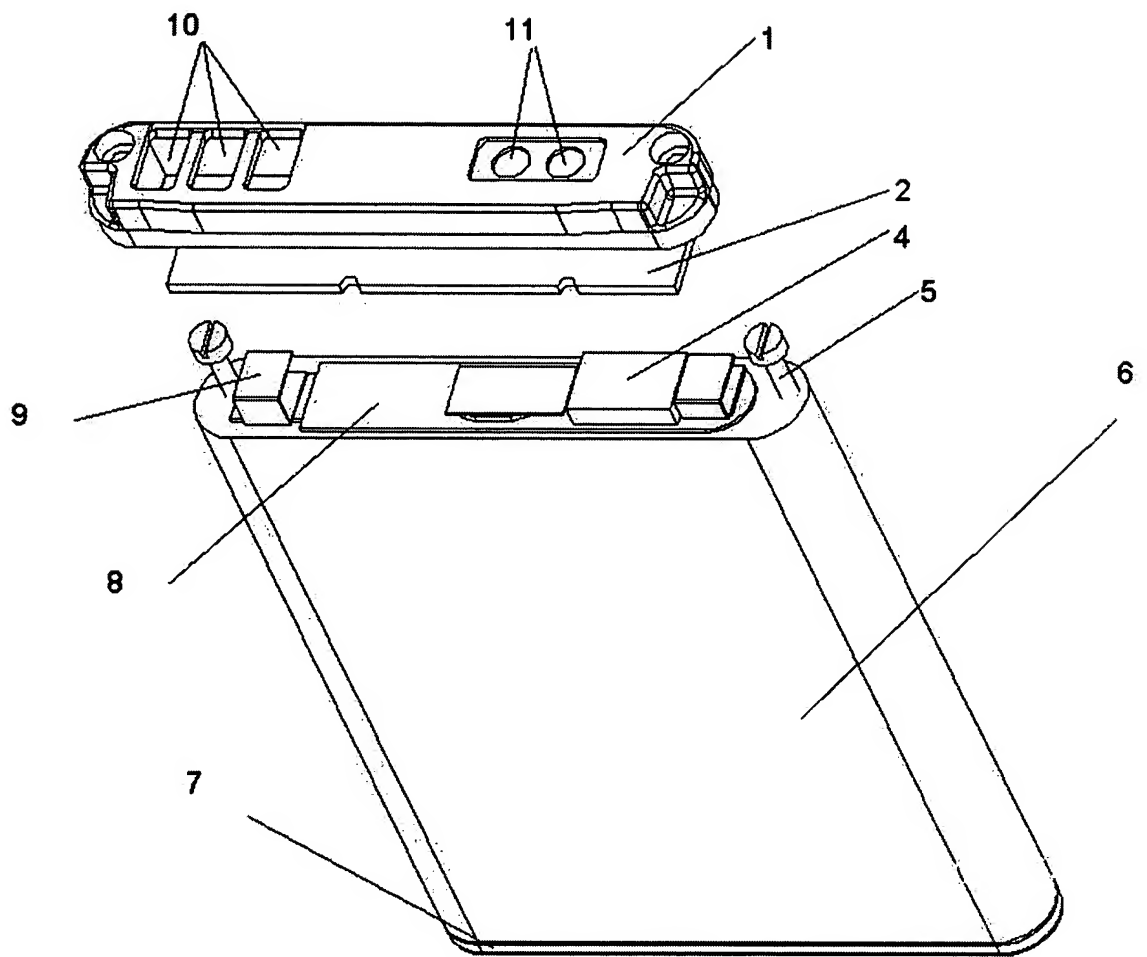


Figure 3

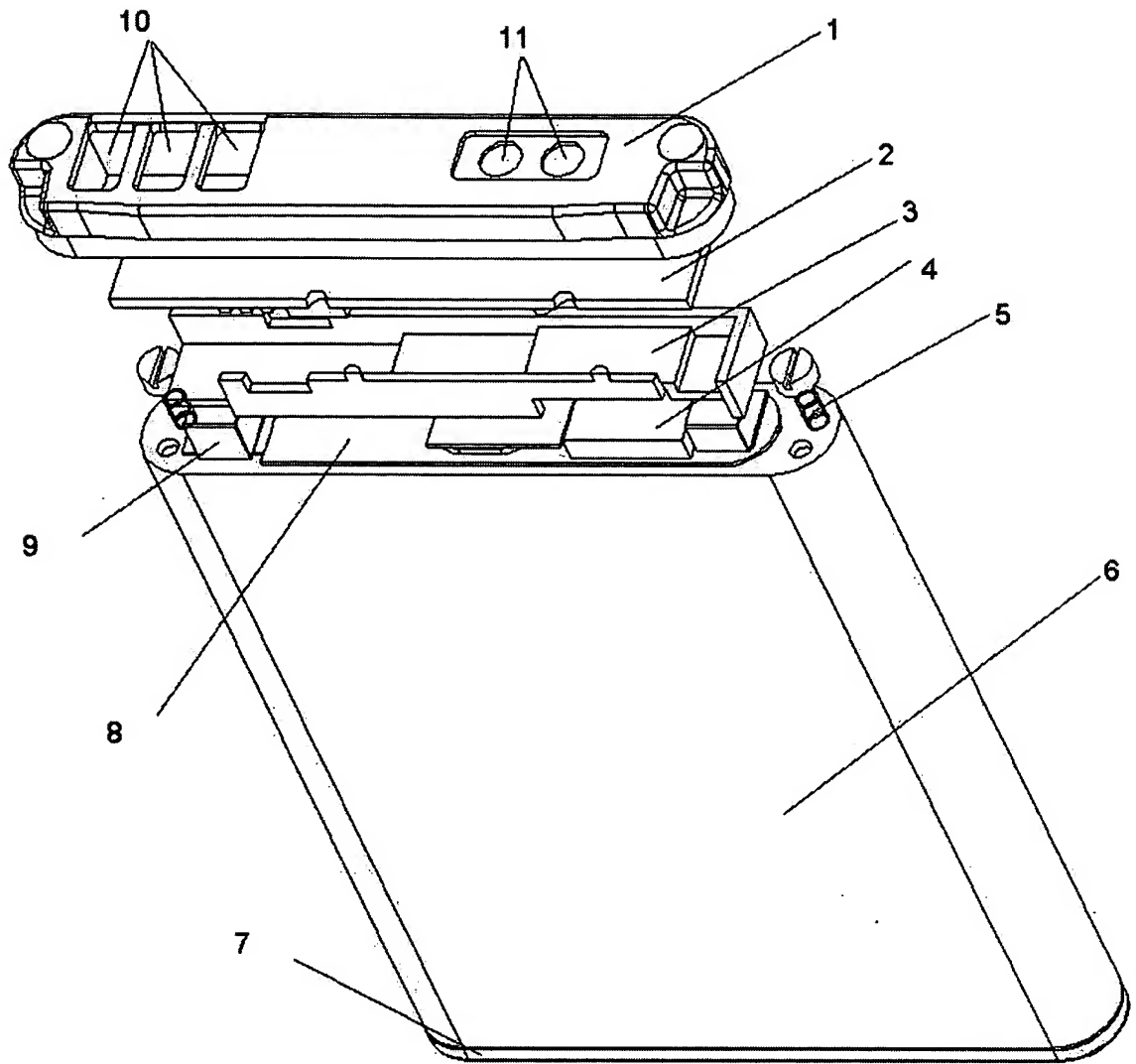


Figure 4

FIGURE FOR ABSTRACT

